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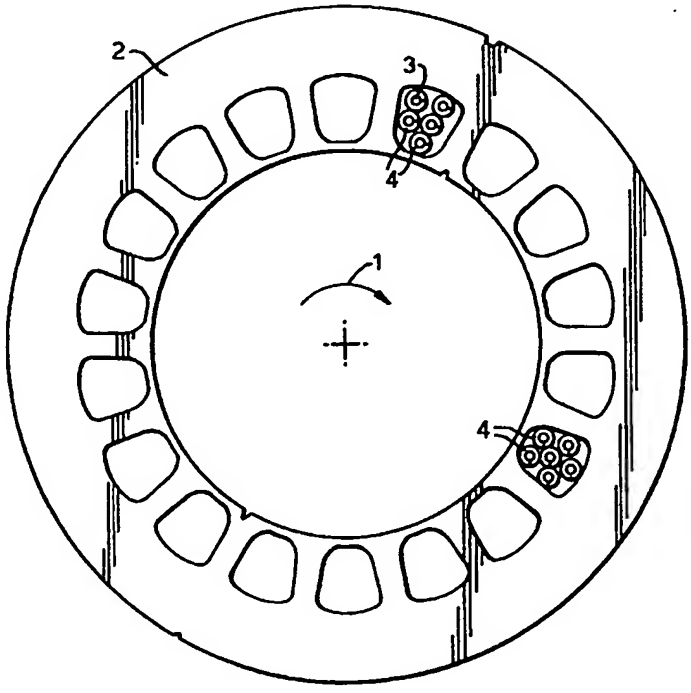
(54) Title: MONITORING INTERNAL PARAMETERS OF ELECTRICAL MOTOR SYSTEMS

(57) Abstract

A process and system for measuring and monitoring data, such as temperature and vibrations, in an electrical motor comprises a fibre optical cable (5) embedded in the electrical insulation (4) of at least one wire (3) of the motor windings which cable thus forms an elongate thermometer and/or vibration sensor.



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MONITORING INTERNAL PARAMETERS OF ELECTRICAL MOTOR SYSTEMS

Description Of Invention

This invention relates to an improved process and system to measure and monitor conditions of electrical submersible motors. The method and system according to the invention thereto employ optic fibers, sensors, and/or micromachines wound integrally with the electrical wire used in the construction of an electrical motor's stator or armature.

One embodiment of the invention wraps optic fiber and sensors familiar to those in the art of telemetry, around the electrical wire, and then encapsulates and attaches the optic fiber to the wire by covering or coating the electrical wire and the optic fiber with an insulation material. Hence the optic fiber and the sensors, machines, and devices are wound longitudinally along the length of the electric wire, and the two are then wound through the electric motor stator slots to form the stator windings. The stator can then have insulation applied to it and the electric wires through varnishing, epoxy coating, or any of the other insulation techniques used by those familiar to the art of making motors. Moreover, the invention allows for the curing temperature of said insulation materials to be closely monitored by using the optic fibers as an intrinsic temperature monitor by using optical time domain reflectometry techniques and Raman backscattering.

Another embodiment places the optic fiber and the associated devices for monitoring in a tube, and the tube is wound in the stator of the electrical motor with the electrical wire.

Another embodiment uses the optic fiber, wound around electrical wire and passed through the stator, to be a communication path between sensors out side of the electric motor.

This invention solves the problem of monitoring internal electrical motor parameters. For example it is often useful from both a design and development prospective as well for operational control, safety, and extending motor life, to monitor certain internal parameters of an electric motor. This invention also allows parameters to be measured along multiple nodes along the axis of the motor as well as at different radial positions in the motor. These variables give useful insight to heat rise, heat flux, hot spots, and the subsequent heat profiles in different motor designs, as well as offering an intimate knowledge of the motors internal conditions of pressure and vibration, and stator movement under during actual running and operation of the electrical system.

Electrical motor performance and life cycle are functions of these internal conditions, which the invention monitors. Therefore, this invention's ability to monitor these conditions in electrical motors allows for improvements and or changes in design and operations to be made and then confirmed via the internal monitoring offered by this invention.

The most direct application of this technology is in the development of new, highly reliable, and more efficient electrical motors for subterranean oil and gas wells.

This invention will be used to design electrical motors that will have the internal parameters measured for many applications. It is often very useful to monitor the internal vibration of an electrical motor in operations to detect poor dampening in the system, poor

alignment of the motor rotor, or vibrations induced by start ups or implements and devices attached to the motors (i.e. compressors, fans, pumps, etc.). This will assist in designing more efficient and reliable electrical motors systems both form a mechanical perspective as well as an electrical perspective. This invention also provides a method to pass optical communications through an electrical motor from outside the electrical motor.

Description of a preferred embodiment

The invention will be described in more detail with reference to the accompanying drawings in which

Fig. 1 is a schematic cross-sectional view of an electrical motor having a stator with electrical wires of which at least one wire is equipped with a fibre optical sensor system embedded in the insulation;

Fig. 2 shows at a larger scale than Fig. 1 a cross-sectional view of the wire with fibre optical sensor system of Fig. 1; and

Fig. 3 shows at a larger scale than Fig. 1 a longitudinal sectional view of the wire and fibre optical sensor system of Fig. 1.

Referring to Fig. 1 there is shown an electrical motor having a rotor represented by arrow 1 and a stator 2 which comprises a series of electrical wires 3 that are wound such that when an electrical current passes through the wires 3 a rotating electromagnetic field is created which induces the rotor 1 to rotate relative to the stator 2. As shown in Fig. 2 and 3 at least one wire 3 has an electrical insulation coating 4 in which a fibre optical cable 5 is embedded, which cable 5 may be provided with suitable microsensors 6, such as an accelerometer to detect vibrations, and/or optic gratings, such as fibre bragg gratings 7 that reflect light of a wavelength equal to the grating width

and allow light of other wavelengths to pass through the cable 7. The gratings 7 may be designed such that the reflected wavelength varies with temperature such that the fibre optical cable 5 forms an elongate string of miniature thermometers along the length of the wire 3. Likewise the optic sensors 6 may be formed by seismic sensors which are formed by similar gratings that reflect varying wavelengths in response to vibrations so that the fibre optical cable 5 is an elongate multiparameter sensor system that accurately detects any overheating and/or vibrations, for example when the associated pump is blocked or runs dry or when a bearing has worn out.

C L A I M S

1. A process for measuring and monitoring electrical motor systems, said process comprising:

providing a motor system having at least one component selected from a stator and an armature, said at least one component connected to at least one electrical wire;

incorporating at least one means for data measurement with said at least one electrical wire;

collecting data with said at least one means for data measurement; and

transferring said collected data to a data collection station.

2. A process according to claim 1 wherein said means for collecting data is wrapped around said electrical wire.

3. A process according to claim 2 wherein said means for collecting data is encapsulated and attached to said electrical wire by covering or coating the electrical wire and the means for collecting data with an insulation material.

4. A process according to claim 1 wherein said means for collecting data is selected from optic fibers, sensors, micromachines, and combinations thereof.

5. A process for measuring and monitoring electrical motor systems, said process comprising:

providing a motor system having at least one motor component selected from a stator and an armature, said at least one component connected to at least one electrical wire;

providing at least one means for data measurement;

connecting said at least one means for data measurement with said at least one motor component;

collecting data with said at least one means for data measurement; and

transferring said collected data to a data collection station.

6. A process according to claim 5 wherein said means for collecting data is contained within a tube.

7. A process according to any preceding claim wherein the motor is an electrical motor of a downhole electrical submersible pump for pumping of hydrocarbon fluids in a well.

8. A system for use in claim 4 which comprises a fibre optical cable provided with physical parameter sensors embedded in an electrical insulation coating surrounding at least one wire of the motor windings.

Fig.1.

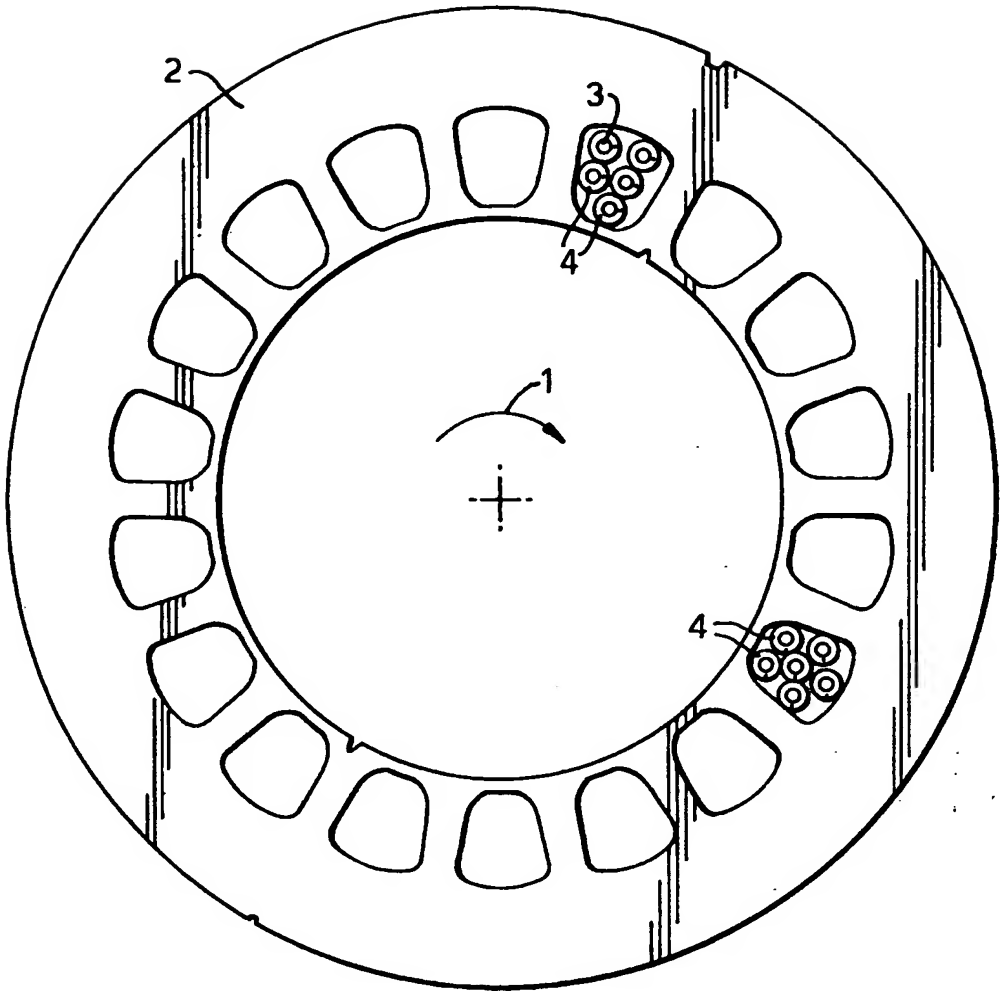
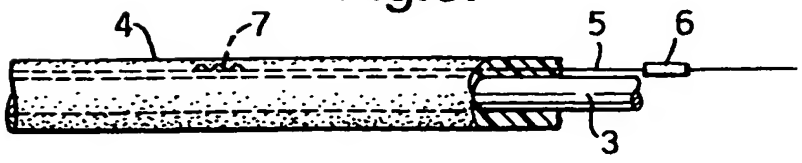


Fig.2.

Fig.3.



INTERNATIONAL SEARCH REPORT

Inte onal Application No
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A. CLASSIFICATION OF SUBJECT MATTER
IPC 7 H02K11/00 H02K3/00

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
IPC 7 H02K G01R H01B

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)
EPO-Internal, WPI Data, PAJ, INSPEC

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category *	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	DE 295 03 853 U (ASTA ELEKTRODRAHT GMBH) 1 June 1995 (1995-06-01) the whole document	1-8
X	US 4 827 487 A (TWERDOCHLIB MICHAEL) 2 May 1989 (1989-05-02) column 3, line 27 -column 5, line 33; figures 1-5	1,5

☐ Further documents are listed in the continuation of box C.

☒ Patent family members are listed in annex.

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Date of the actual completion of the international search	Date of mailing of the international search report
7 August 2000	17/08/2000

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INTERNATIONAL SEARCH REPORT

information on patent family members

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Patent document cited in search report	Publication date	Patent family member(s)	Publication date
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US 4827487 A	02-05-1989	NONE	